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NASA-03413 (June 2004)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA

Superseding NASA-03413 (December 2003)

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DIVISION 03 - CONCRETE

SECTION 03413

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SECTION 03413

STRUCTURAL PRECAST, PRETENSIONED CONCRETE-PLANT CAST

06/04

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers fabrication and erection of precast structural concrete framing elements, floor units, and roof units for buildings including, as required by the project, the following:

Precast conventionally reinforced concrete floor and roof units for clear spans up to 35 feet 10.5 meter

Precast conventionally reinforced concrete columns, joists, beams, and other structural framing elements

Precast prestressed concrete single- and double-tee slabs, hollow-cored flat slabs, tee- or keystone-joists, columns, and other structural elements

Precast concrete cellular floor units with cells suitable for use as electrical raceways

Drawings must include a complete design indicating the character of the work to be performed and giving the following:

Assumed loads, including floor live load, roof live load, wind load, concentrated loads such as partitions, and equipment mounted on or suspended from precast concrete construction, concrete floor topping weight, and other design data as may be required for the proper preparation of shop drawings

Layout of the framing system indicating the relative location of the various precast structural concrete sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required precast structural concrete framing system

Details of all precast structural concrete sections indicating cross-sections and dimensions

Location of precast structural concrete sections

having an architectural finish on exposed-to-view surfaces when required

Details of reinforcement indicating reinforcing-bar schedules; location and size of welded-wire fabric; and tenons for prestressed concrete indicating the final stressing force in kips, as required

Details of connections indicating end bearing minimums and anchorage devices and other items embedded in the precast structural concrete sections

Location and details of concrete floor topping, when required

Details of openings including the size of steel framing members as required

Details of precast concrete filler blocks, as required

Details of hangers for suspended ceilings, ducts, piping, lighting fixtures, conduit, or other construction, as required

Precast concrete floor-unit cells that will be used for electrical raceways, when required

When both fire-resistance-rated construction and nonrated construction are required, the location of fire-resistance-rated construction

Cast-in-place normal-weight concrete, including concrete floor topping, is specified in Section 03305 CAST-IN-PLACE CONCRETE (SHORT SECTION).

Precast conventionally reinforced concrete wall panels, solid-section type, are specified in Section 03475 PRECAST CONCRETE WALL PANELS.

Cast-in-place lightweight noninsulating concrete fills are specified in Section 03331 LIGHTWEIGHT ARCHITECTURAL CONCRETE.

Precast-concrete roof slabs placed over purlings or joists spaced not more than 8 feet on center are specified in Section 03435 PRECAST CONCRETE DECK.

Sealing joints in exposed-to-view surfaces of precast concrete slabs, such as at ceilings and walls, is specified in Section 07920 SEALANTS AND CALKINGS.

Painting exposed-to-view surfaces of precast concrete units such as ceilings, is specified in Section 09920 ARCHITECTURAL PAINTING."

When cells of precast concrete cellular floor units will be used for electrical raceways, the inspection

of cells to be used for electrical raceways, cutting the floor units for inserts, and electrical raceway fittings are specified in Section 16145 MANUFACTURED WIRING SYSTEMS.

Fire-resistance-rated construction using precast structural concrete sections is described in Underwriters Laboratories, Inc., "Fire Resistance Ratings (BXUV)" included in UL Fire Resistance Directory and the "Fire-Resistance Ratings" contained in AIA CO-1. Fire-resistance-rated construction limits the types of precast structural concrete sections; the requirements for end restraint; the concrete materials and proportions of concrete mix for floor top fill; the requirements for grouting and sealing joints; and the type of roof insulation and roof covering.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

****

The publications listed below form a part of this section to the extent referenced:

ACI INTERNATIONAL (ACI)

ACI 211.1	(1997) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 306R	(1988) Cold Weather Concreting
ACI 318/318R	(2002) Building Code Requirements for Structural Concrete and Commentary
ACI 347	(1989) Formwork for Concrete
ACI SP-66	(1994) ACI Detailing Manual

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 200	(1973; Rev 2000) Epoxy Protective Coatings

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1	(2003) Specification for Carbon Steel

	Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2004) Structural Welding Code - Steel
AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2004) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 185	(2002) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 283/A 283M	(2003) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 322	(1991; Rev 2001) Standard specification Steel Bars, Alloy, Standard Grades
ASTM A 36/A 36M	(2003a) Standard Specification for Carbon Structural Steel
ASTM A 370	(2003a) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 416/A 416M	(2002) Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A 421	(2002) Standard Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A 615/A 615M	(2004) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	(2003) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 82	(2002) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 109/C 109M	(2002) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 1107	(2002) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 114	(2004) Standard Test Method for Chemical

	Analysis of Hydraulic Cement
ASTM C 115	(1996a; R 2003) Standard Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C 117	(2003) Standard Test Method for Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(2003) Standard Test Method for Lightweight Particles in Aggregate
ASTM C 126	(1999) Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM C 127	(2001) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2001e1) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2003) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2001) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138/C 138M	(2001a) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 142	(1997) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143/C 143M	(2003) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2002ae1) Standard Specification for Portland Cement
ASTM C 151	(2000) Standard Test Method for Autoclave Expansion of Portland Cement
ASTM C 157/C 157M	(2003) Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar, and Concrete
ASTM C 172	(1999) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2001e1) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 183	(2002) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 185	(2002) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C 191	(2004) Standard Test Method for Time of Setting Hydraulic Cement by Vicat Needle
ASTM C 192/C 192M	(2002) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 204	(2000) Standard Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
ASTM C 231	(2003) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 232	(1999) Standard Test Methods for Bleeding of Concrete
ASTM C 233	(2001) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C 260	(2001) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 266	(2003) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C 29/C 29M	(1997) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 31	(2000e1) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 330	(2004) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 39/C 39M	(2003) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	(1999) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 403/C 403M	(1999) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

ASTM C 404	(2003) Standard Specification for Aggregates for Masonry Grout
ASTM C 42/C 42M	(2003) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 451	(2004) Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
ASTM C 535	(2003e1) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 595	(2003) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2003) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 70	(1994; R 2001) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 78	(2002) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 88	(1999a) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94/C 94M	(2003a) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2004) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1149	(1999) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D 2103	(2003) Standard Specification for Polyethylene Film and Sheeting
ASTM D 2240	(2003) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D 312	(2000) Standard Specification for Asphalt Used in Roofing

ASTM D 3744	(2003) Standard Test Method for Aggregate Durability Index
ASTM D 395	(2003) Rubber Property - Compression Set
ASTM D 412	(1998a; R 2002e1) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D 4397	(2002) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 471	(1998e1) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D 573	(2002) Standard Test Method for Rubber-Deterioration in an Air Oven
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM D 797	(1982; R 1989) Rubber Property - Young's Modulus at Normal and Subnormal Temperatures
ASTM E 165	(2002) Standard Test Method for Liquid Penetrant Examination
ASTM E 621	(1994; R 1999e1) Standard Practice for Use of Metric (SI) Units in Building Design and Construction
ASTM E 709	(2001) Standard Guide for Magnetic Particle Examination

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 1 MSP	(2001e27) Manual of Standard Practice
CRSI A48.1	(1986) Concrete Construction - Forms for One Way Concrete Joist Construction
CRSI A48.2	(1986) Concrete Construction - Forms for Two Way Concrete Joist Construction

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 58	(1973) Basic Hardboard

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS MMM-A-001993	(1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)
FS UU-B-790	(1992) Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

UNDERWRITERS LABORATORIES (UL)

UL Elec Const Dir	(2003) Electrical Construction Equipment Directory
UL Fire Resist Dir	(2003) Fire Resistance Directory

1.2 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.
****

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings be submitted in accordance with the paragraphs entitled, "Fabrication" and "Drawings," of this section.

Installation Drawings be submitted in accordance with the paragraph entitled, "Drawings," of this section.

SD-05 Design Data

Mix design data shall be submitted in accordance with the paragraph entitled, "Concrete Design Mixes," of this section.

Normal Weight Concrete
Lightweight Structural Concrete

SD-06 Test Reports

Test reports for the following items shall be submitted in accordance with paragraph entitled, "Concrete Sampling and Testing," of this section. Each report shall contain the project name and number, date, name of Contractor, name of precast-concrete manufacturer, name of concrete testing service, type of concrete, structural-member identification letter and number, design compressive strength at 28 calendar days, concrete-mix proportions and materials, compressive breaking strength and type of break, a record of gage pressures or dynamometer readings, compression strength of concrete at time of detensioning, and type of reinforcement. Design mix reports shall be approved at least 15 calendar days prior to start of work.

Air Content
Air Entrainment
Compressive Strength
Slump

Moisture Content
Design Mix
Unit Weight

SD-07 Certificates

Certificates of Compliance for the following items shall include qualifications of personnel, location of plant, concrete batching facilities, manufacturer equipment and facilities, a list of projects similar to specified work, handling and erection equipment, and performance requirements. Certificates for welder qualifications shall be in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Installers
Manufacturer
Aggregate
Pretensioning
Detensioning

Welding Procedures shall be submitted in accordance with AWS D1.1/D1.1M.

SD-08 Manufacturer's Instructions

Installation Instructions shall indicate the manufacturer's recommended sequence and methods of installation for the following items:

Welding Sequence and Procedure
Epoxy-Resin Grout
Epoxy-Resin Adhesive

1.3 QUALIFICATIONS FOR PRECAST-CONCRETE MANUFACTURER

Precast structural concrete sections shall be manufactured by an organization experienced in the manufacture of precast concrete.

A written description of the Manufacturer shall be submitted giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work, and other information as may be required.

1.4 QUALIFICATIONS FOR INSTALLER

Members shall be installed by an organization experienced in the installation of precast structural-concrete sections.

A written description of Installers shall be submitted giving the qualifications of personnel, handling and erection equipment, list of projects similar to specified work, and other information as may be required.

1.5 QUALIFICATIONS FOR WELDING WORK

****
NOTE: If Section 05095 WELDING STEEL CONSTRUCTION is not included in the project specification, applicable requirements therefore should be inserted

and the following paragraph deleted.
****

[Section 05095 WELDING STEEL CONSTRUCTION applies to work specified in this section.]

[Welding Procedures shall be in accordance with AWS D1.1/D1.1M.]

[Welders shall have been qualified by tests in accordance with AWS D1.1/D1.1M.]

[Welders shall be permitted to make only those types of weldments for which each is specifically qualified.]

Installation instructions for the Welding Sequence and Procedure shall be provided by the Contractor which indicates the manufacturer's recommended sequence and method of installation.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Design Methods

Design shall be in accordance with ACI 318/318R.

1.6.2 Allowable Design Loads and Deflections

****
NOTE: Allowable design loads must be indicated and shall include dead loads, live loads, stationary loads, concentrated moving loads, deflection of roof slab sections, etc.

Recommended design loads are specified in article ix of the National Building Code, recommended by the American Insurance Association AIA CO-1 and ANSI A58.1.
****

Allowable design loads and deflections shall be as indicated.

1.6.3 UL Fire-Resistance Listing and Label

****
NOTE: Delete paragraph heading and the following paragraph when UL-listed fire-resistant precast structural concrete sections are not required. The UL lists several manufacturers of prestressed precast-concrete hollow-core flat slabs and single-tee and double-tee slabs. Location and fire-resistance classification of fire-resistant-rated structural sections must be indicated.
****

Sections indicated requiring a fire-resistance classification shall be listed in UL Fire Resist Dir, part entitled, "Precast Concrete Units (CFTV)," and each section shall bear the UL label and marking.

1.6.4 Electrical Raceway UL Listing and Label

****
NOTE: Delete paragraph heading and the following paragraph when hollow-core floor-slab precast structural sections will not be used for electrical raceways, either under this contract or in the future. Location of electrical raceway structural sections must be indicated.
****

Hollow-core floor slabs indicated as electrical raceways shall be listed in UL Elec Const Dir, part entitled, "Raceways (RGKT) Cellular Concrete Floor (RGYR)," and each section shall bear the UL label and marking.

1.7 CONCRETE SAMPLING AND TESTING

1.7.1 Tests for Concrete Materials

****
NOTE: Delete the following materials and tests that are not required.
****

Concrete materials proposed for use in the work shall be sampled and tested as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete aggregates for normal-weight concrete	Sampling	ASTM D 75	One for each material source and grading size
	Sieve analysis	ASTM C 136	
	Calculating fineness modulus	ASTM C 126	
	Amount of material passing No. 200 sieve	ASTM C 117	
	Amount of friable particles	ASTM C 142	
	Amount of organic impurities	ASTM C 40	
	Amount of coal and lignite	ASTM C 123	
	Magnesium sulfate soundness test	ASTM C 88	
	Aggregate durability	ASTM D 3744	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Compact unit weight of slag (coarse aggregate)	ASTM C 29/C 29M	
	Resistance to abrasion test of small size coarse aggregate	ASTM C 131 or ASTM C 535	
Lightweight aggregates for structural concrete	Sampling	ASTM D 75	One for each material source and grading size
	Sieve analysis	ASTM C 136 ASTM C 330	
	Compact unit Unit weight (loose)	ASTM C 29/C 29M and ASTM C 330	
Lightweight structural concrete using the proposed lightweight aggregates	Specimen preparation	ASTM C 192/C 192M and ASTM C 330	As required for each type of test to determine conformance
	Compressive strength	ASTM C 39/C 39M	
	Unit-weight	ASTM C 330	
	Shrinkage	ASTM C 157/C 157M and ASTM C 330	
Hydraulic cement	Sampling	ASTM C 183	One for each material source, type, and color
	Chemical analysis	ASTM C 114	
	Fineness	ASTM C 115 or ASTM C 204	
	Autoclave expansion	ASTM C 151	
	Time of setting	ASTM C 191 or ASTM C 266	
	Air content of mortar	ASTM C 185	
	Compressive strength	ASTM C 109/C 109M	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Heat of hydration	ASTM C 185	
	False set	ASTM C 451	
Air entraining admixture using air-entraining concrete made of the proposed concrete materials	Materials for tests	ASTM C 233	One set of tests for each type of portland cement proposed for use and for each type of concrete
	Number of specimens	ASTM C 233, Table 1	
	Bleeding	ASTM C 232	
	Time of setting	ASTM C 403/C 403M and ASTM C 233	
	Compressive-strength test specimen	ASTM C 192/C 192M and ASTM C 233	
	Compressive-strength test at 3, 7, and 28 calendar days	ASTM C 39/C 39M and ASTM C 233	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete aggregates for normal-weight concrete	Sampling	ASTM D 75	One for each material source and grading size
	Sieve analysis	ASTM C 136	
	Calculating fineness modulus	ASTM C 126	
	Amount of material passing 75 micrometer sieve	ASTM C 117	
	Amount of friable particles	ASTM C 142	
	Amount of organic impurities	ASTM C 40	
	Amount of coal and lignite	ASTM C 123	
	Magnesium sulfate soundness	ASTM C 88	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	test		
	Aggregate durability	ASTM D 3744	
	Compact unit weight of slag (coarse aggregate)	ASTM C 29/C 29M	
	Resistance to abrasion test of small size coarse aggregate	ASTM C 131 or ASTM C 535	
Lightweight aggregates for structural concrete	Sampling	ASTM D 75	One for each material source and grading size
	Sieve analysis	ASTM C 136 ASTM C 330	
	Compact unit Unit weight (loose)	ASTM C 29/C 29M and ASTM C 330	
Lightweight structural concrete using the proposed lightweight aggregates	Specimen preparation	ASTM C 192/C 192M and ASTM C 330	As required for each type of test to determine conformance
	Compressive strength	ASTM C 39/C 39M	
	Unit-weight	ASTM C 330	
	Shrinkage	ASTM C 157/C 157M and ASTM C 330	
Hydraulic cement	Sampling	ASTM C 183	One for each material source, type, and color
	Chemical analysis	ASTM C 114	
	Fineness	ASTM C 115 or ASTM C 204	
	Autoclave expansion	ASTM C 151	
	Time of	ASTM C 191	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	setting	or ASTM C 266	
	Air content of mortar	ASTM C 185	
	Compressive strength	ASTM C 109/C 109M	
	Heat of hydration	ASTM C 185	
	False set	ASTM C 451	
Air entraining admixture using air-entraining concrete made of the proposed concrete materials	Materials for tests	ASTM C 233	One set of tests for each type of portland cement proposed for use and for each type of concrete
	Number of specimens	ASTM C 233, Table 1	
	Bleeding	ASTM C 232	
	Time of setting	ASTM C 403/C 403M and ASTM C 233	
	Compressive-strength test specimen	ASTM C 192/C 192M and ASTM C 233	
	Compressive-strength test at 3, 7, and 28 calendar days	ASTM C 39/C 39M and ASTM C 233	

1.7.2 Concrete Design Mixes

****
NOTE: Delete the following types of concrete and tests not required.
****

Concrete Design Mix for concrete used shall be determined and tested as follows:

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Normal weight concrete	Specific gravity and absorption of fine aggregate	ASTM C 128	As required for the concrete aggregates for each trial mix
	Specific	ASTM C 127	

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	gravity and absorption of coarse aggregate		
	Moisture Content tent of both fine and coarse aggregate	ASTM C 70 and ASTM C 566	
	Dry-rodded Unit Weight of coarse aggregate	ASTM C 29/C 29M	
	Trial mixes using at least three different water/cement ratios, minimum allowable cement content, maximum allowable slump; all with Air Entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified in the paragraph entitled, "Quality of Concrete"
	Making and curing concrete specimens in the laboratory	ASTM C 192/C 192M	Two sets of three specimens for each design mix
	Sampling fresh concrete in the laboratory	ASTM C 192/C 192M	One for each set of design mix specimens
	Slump	ASTM C 143/C 143M	
	Air Content	ASTM C 231	
	Yield	ASTM C 138/C 138M	
	Compressive strength	ASTM C 39/C 39M	Three specimens tested at 28 calendar days
Lightweight structural concrete	Dry loose unit weight of aggregates	ASTM C 29/C 29M and ASTM C 330	As required for the lightweight aggregate for each trial mix
	Moisture content of aggregate	ASTM C 566	
	Trial mixes using at least	ACI 211.1	As required to determine the

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	three different water/cement ratios, maximum allowable slump; both with and without air entrainment		concrete mix having the properties specified in the paragraph entitled, "Quality of Concrete"
	Making and curing concrete the laboratory	ASTM C 192/C 192M	Two sets of for each design mix
	Sampling fresh concrete in the laboratory	ASTM C 192/C 192M	One for each set of design mix specimens
	Slump	ASTM C 143/C 143M	
	Air content	ASTM C 173/C 173M	
	Yield	ASTM C 138/C 138M	
	Compressive strength	ASTM C 39/C 39M	Three specimens tested at 7 calendar days and three specimens tested at 28 calendar days
	Air-dried unit weight	ASTM C 330	Two specimens tested after curing 28 calendar days

****
NOTE: Delete the following paragraph when normal-weight concrete is not required.
****

From the results of the tests for normal-weight concrete, plot a curve showing the relationships between water/cement ratios and compressive strengths. Maximum permissible water/cement ratio shall be the value not exceeding the maximum water/cement ratio specified for normal-weight concrete properties shown by the curve to produce a design-minimum laboratory Compressive Strength at 28 calendar days not less than that specified.

****
NOTE: Delete the following paragraph when lightweight structural concrete is not required.
****

From the results of the tests for lightweight structural concrete, plot a curve showing the relationships between cement contents and compressive

strengths. Minimum permissible cement content shall be the value not less than the minimum cement content specified for lightweight structural properties shown by the curve to produce a design-minimum laboratory compressive strength at 28 calendar days not less than that specified.

1.7.3 Quality Control Testing During Fabrication

****
NOTE: Delete the following types of concrete not required by the project.
****

Concrete shall be sampled and tested for quality control during fabrication as follows:

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Normal weight concrete	Sampling of fresh concrete	ASTM C 172 except modified for slump per ASTM C 94/C 94M	As required for each test
	Slump test	ASTM C 143/C 143M	One for each concrete load at point of discharge and one for each set of compressive strength test
	Air Content by pressure method	ASTM C 231	One for each set of compressive-strength tests
	Compression test specimens	ASTM C 31	One set of six standard cylinder specimens for each compressive strength test

Curing of compression test specimens shall be the same as the curing method used for the precast-concrete structural members.

Concrete temperature		Each time a set of compression-test specimens is made
Compressive strength tests	ASTM C 39/C 39M	One set for every ten structural members, or fraction thereof,

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
			cast in any one day; two specimens tested at 7 calendar days, three specimens tested at 28 calendar days, and one specimen retained in reserve for testing if required
Lightweight structural concrete	Sampling fresh concrete	ASTM C 172 except modified for slump per ASTM C 94/C 94M	As required for each test
	Slump test and unit weight of fresh concrete	ASTM C 143/C 143M ASTM C 138/C 138M	One for each concrete load at point of discharge and one for each set of compressive-strength tests
	Air content by volumetric method	ASTM C 173/C 173M	One for each set of compressive-strength tests
	Compressive test specimens	ASTM C 31	One set of six standard cylinder specimens for each compressive-strength test

The curing of Compressive Strength test specimens shall be the same as the curing method used for the precast-concrete structural members.

	Concrete temperature	Each time a set of compression test specimens is made
	Compressive-strength tests	ASTM C 39/C 39M	One set for every ten structural members, or fraction thereof,

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
			as in any one day; two specimens tested at 7 calendar days, three specimens tested at 28 calendar days, and one specimen retained in reserve for testing if required
	Air-dried Unit Weight at 28 calendar days	ASTM C 330	One for each compressive strength test

Test results shall be submitted on the same day that tests are made.

1.8 DRAWINGS

Fabrication Drawings for precast structural concrete sections shall show type and location of all reinforcement, size and spacing of welds.

Installation Drawings for precast structural concrete sections shall indicate type and location of all anchorage devices, size and spacing of all welded connections, grouting and joint sealant details, and dimensions and locations of all openings in structural concrete sections.

PART 2 PRODUCTS

2.1 QUALITY OF CONCRETE

2.1.1 Normal-Weight Concrete Properties

****
NOTE: Delete paragraph heading and the following paragraphs when normal-weight concrete will not be required.
****

PROPERTY	VALUE
Design Compressive Strength at 28 calendar days	Not less than 5,000 psi
Maximum Aggregate size	3/4 inch
Maximum water/cement ratio	4.25 gallons per 94-pound sack of cement
Slump at point of concrete discharge	Not to exceed 3 inches

PROPERTY	VALUE
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 8 percent

PROPERTY	VALUE
Design Compressive Strength at 28 calendar days	Not less than 34.5 Megapascal
Maximum Aggregate size	19 millimeter
Maximum water/cement ratio	16 liter per 42.5 kilogram sack of cement
Slump at point of concrete discharge	Not to exceed 75 millimeter
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 8 percent

2.1.2 Lightweight Structural Concrete Properties

****

NOTE: Delete paragraph heading and the following paragraphs when light-weight structural concrete will not be required.

****

PROPERTY	VALUE
Design compressive strength at 28 calendar days	Not less than 5,000 psi
Maximum size Aggregate	3/4 inch
Minimum cement content	Seven 94-pound sacks of cement per cubic yard
Slump at point of concrete discharge	Not to exceed 3 inches
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 8 percent
Air-dry density at 28 calendar days	Not less than 90 nor more than 115 pounds per cubic foot

PROPERTY	VALUE
Design compressive strength at 28 calendar days	Not less than 34.5 Megapascal

PROPERTY	VALUE
Maximum size Aggregate	19 millimeter
Minimum cement content	Seven 42.5 kilogram sacks of cement per 0.75 cubic meter
Slump at point of concrete discharge	Not to exceed 75 millimeter
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 8 percent
Air-dry density at 28 calendar days	Not less than 1440 nor more than 1840 kilogram per cubic meter

2.2 CONCRETE MATERIALS

2.2.1 Aggregates

****
NOTE: Delete paragraph heading and the following paragraphs when precast structural-concrete sections will be fabricated of lightweight structural concrete. Precast concrete elements that will be exposed to the weather must be fabricated of normal-weight concrete. When an architectural finish, such as exposed aggregate, is required for exposed-to-view surfaces, refer to Section 03475 PRECAST CONCRETE WALL PANELS for concrete aggregate specifications.

Delete the following paragraph when both normal-weight concrete and lightweight structural concrete is required.
****

Aggregates shall be fine and coarse conforming to ASTM C 33 and the following:

****
NOTE: Delete the following paragraph when precast structural concrete sections will be fabricated of normal-weight concrete.
****

Aggregates for normal-weight concrete shall be fine and coarse conforming to ASTM C 33 and the following:

Where a structural member will be exposed to the weather, concrete aggregates shall meet the requirements of ASTM C 33 for fine aggregate subject to abrasion, for coarse aggregate subject to severe exposure, and for all concrete aggregates where surface appearance of the concrete is important.

Maximum size of coarse aggregate shall be as specified.

2.2.2 Lightweight Aggregates

****
NOTE: Delete paragraph heading and the following paragraph when all precast structural-concrete sections will be fabricated of normal-weight concrete. Fire-resistance-rated structural sections may be fabricated of lightweight structural concrete, especially when the fire-resistance rating exceeds 2 hours.
****

Aggregates shall be fine and coarse for structural concrete, conforming to ASTM C 330.

2.2.3 Portland Cement

****
NOTE: If high early strength concrete is required, add Type III.
****

[Portland cement shall conform to ASTM C 150, Type [_____].]

[Blended hydraulic cement shall conform to ASTM C 595, Type [_____].]

One brand and type of cement shall be used for formed concrete having exposed-to-view finished surfaces.

2.2.4 Fly Ash

Fly ash [is required] [used] as an admixture [and] shall conform to ASTM C 618, Class [C or F] with 4 percent maximum loss on ignition and between 15 to 35 percent maximum cement replacement by weight.

****
NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material. Written justification may be submitted on a Request for Waiver Form to the NASA Environmental Program Manager for approval. The Request for Waiver Form is located in the NASA Procedures and Guidelines (NPG 8830.1) (http://nodis3.gsfc.nasa.gov).
****

2.2.5 Ground Granulated Blast Furnace (GGBF) Slag

GGBF slag [is required] [used] as an admixture [and] shall conform to ASTM C 989, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

2.2.6 Air-Entraining Admixture

Admixture shall be free of sodium chloride and nitrates and shall conform to ASTM C 260.

2.2.7 Water

Water shall be potable.

2.3 REINFORCEMENT MATERIALS

****
NOTE: Delete the following reinforcement materials that are not required. Concrete reinforcement materials are required for both conventionally reinforced and prestressed precast structural-concrete sections.
****

2.3.1 Reinforcement Bars

Bars shall be deformed and shall conform to ASTM A 615/A 615M, Grade 60, except that 9.5 millimeter diameter bars may be Grade 40.

****
NOTE: Delete the following paragraph when galvanized reinforcing bars for concrete reinforcement will not be required. Galvanizing is recommended when the concrete cover over reinforcing bars is less than 1-1/2 inches 38 millimeter for structural sections exposed to the weather.
****

Bars for structural sections exposed to the weather shall be galvanized in accordance with ASTM A 153/A 153M.

2.3.2 Cold-Drawn Steel Wire

Wire shall conform to ASTM A 82.

2.3.3 Welded-Wire Fabric

****
NOTE: Select one of the following paragraphs as applicable to the project.
****

Fabric shall be uncoated wire conforming to ASTM A 185.

Fabric shall be wire conforming to ASTM A 185. Fabric in structural sections exposed to the weather shall be galvanized. Elsewhere, fabric shall be uncoated.

2.3.4 Supports for Concrete Reinforcement

Supports shall include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcement bars and wire in place.

Supports shall be wire conforming to ACI 347, CRSI A48.1, CRSI A48.2, ASTM E 621, ACI SP-66 and CRSI 1 MSP.

Legs of supports in contact with formwork for sections that will be exposed to weather shall be hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

2.4 PRESTRESSING MATERIALS

****
NOTE: Delete paragraph heading and the following paragraphs when prestressed structural-concrete sections are not required.
****

2.4.1 Strand Tendons

****
NOTE: Strand tendons for prestressed concrete are primarily intended for use in pretensioned, bonded, prestressed concrete construction.
****

Tendons shall be uncoated, 7-strand, stress-relieved, steel wire conforming to ASTM A 416/A 416M.

2.4.2 Wire Tendons

****
NOTE: Delete paragraph heading and the following paragraph when wire tendons for prestressed concrete will not be required. Prestressing steel wire is commonly used in prestressed linear concrete construction in which the steel wire ends are anchored by cold-end deformation (that is, button anchorage) or in which the steel wire ends are anchored by wedges.
****

Tendons shall conform to ASTM A 421, Type BA or Type WA, as required to suit the steel-wire anchorage method used.

2.4.3 Steel-Bar Tendons

****
NOTE: Delete paragraph heading and the following paragraphs when steel-bar tendons for prestressed concrete will not be required. Steel bars are principally used in post tensioning.
****

Tendons shall be uncoated, round steel bars conforming to ASTM A 322.

Tensile properties of the bars after processing, when tested in accordance with ASTM A 370, shall be as follows:

****
NOTE: Select one of the following values of tensile property and value as applicable to the project.
****

TENSILE PROPERTY	VALUE NO. 1	VALUE NO. 2
Ultimate tensile strength	145,000 psi min	160,000 psi min
Yield strength (0.2-percent offset)	130,000 psi min	140,000 psi min
Elongation at rupture in 20 diameters	4 percent min	4 percent min
Reduction on area at rupture	25 percent min	20 percent min

TENSILE PROPERTY	VALUE NO. 1	VALUE NO. 2
Ultimate tensile strength	1000 Megapascal min	1100 Megapascal min
Yield strength (0.2-percent offset)	900 Megapascal min	970 Megapascal min
Elongation at rupture in 20 diameters	4 percent min	4 percent min
Reduction on area at rupture	25 percent min	20 percent min

2.4.4 Tendon Anchorages for Pretensioning

Tendon anchorages shall be capable of anchoring reinforcement without slippage after seating.

Steel cases for prestressing steel strand shall be prooftested by the manufacturer to at least 90 percent of the ultimate tensile strength of the strand.

2.4.5 Tendon Anchorages for Post Tensioning

****
NOTE: Delete paragraph heading and the following paragraphs when tendon anchorages for post tensioning will not be required. Normally, pretensioning only is required for prestressed precast structural concrete sections for building construction. Post tensioning may be required for field connections.
****

Anchorages shall be capable of developing 100 percent of the guaranteed ultimate tensile strength of the reinforcement for prestressed concrete

without excessive deformation. Anchorage plates shall be of sufficient size to keep bearing pressures within the stress allowed by ACI 318/318R for the specified concrete strength at stressing.

Test data confirming the adequacy of anchorages shall be submitted.

2.5 CONNECTION MATERIALS

2.5.1 Steel Plates, Shapes, and Bars

Plates shall conform to ASTM A 283/A 283M, Grade C, or to ASTM A 36/A 36M.

Structural-steel shapes shall conform to ASTM A 36/A 36M.

Bar shapes, flats, and rounds shall conform to ASTM A 675/A 675M, Grade 65, or ASTM A 36/A 36M.

2.5.2 Steel Anchor Bolts

****

NOTE: Delete paragraph heading and the following paragraph when anchor bolts will not be required. Anchor bolts are normally required for precast concrete column base connections.

****

Anchor bolts shall be steel with steel hexagon nuts and steel washers.

2.5.3 Electrodes for Welding

****

NOTE: Delete paragraph heading and the following paragraphs when welded connections will not be required.

****

Electrodes for manual shielded metal-arc welding connections consisting of structural quality carbon-steel members shall conform to the AWS Code and shall be covered mild-steel electrodes conforming to AWS A5.1, E60 series.

Electrodes for welding steel bars for concrete reinforcement shall conform to AWS D1.4.

2.5.4 Flexible Bearing Pads

****

NOTE: Delete one of the following paragraphs as applicable to the project. Delete paragraph heading and the following paragraphs when flexible bearing pads are not required. Hardboard bearing pads are recommended for gravity connections having a bearing load not exceeding 250 pounds per square inch (psi) 1725 kilopascal. Elastomeric nonlaminated bearing pads are recommended for gravity connections having a bearing load not exceeding 800 psi 5500 kilopascal. Where the bearing load exceeds 800 psi 5500 kilopascal or where there are small rotations, laminated type bearing pads designed and constructed to meet the requirements for loading and movement

must be considered. The location and size of flexible bearing pads must be indicated.
****

Pads shall be tempered hardboard, not less than 1/8 inch 3 millimeter in thickness, smooth-two-sides, conforming to NIST PS 58.

Pads shall be molded or cut from elastomeric material. Pad dimensions shall be as indicated and shall be within the following tolerances: thickness, plus or minus 1/16 inch 1.5 millimeter; width, minus 1/8 to plus 1/4 inch 3 to plus 6.5 millimeter; length, plus or minus 1/8 inch 3 millimeter. Material shall be a vulcanized, chloroprene elastomeric compound conforming to the following tests:

PROPERTY	TEST METHOD	PERFORMANCE
Hardness Shore A durometer	ASTM D 2240	70 plus or minus 5 points
Tensile strength	ASTM D 412, Die C	Not less than 2,500 psi
Ultimate elongation	ASTM D 412, Die C	Not less than 300 percent
Resistance to oil aging: change in volume after 70-hour immersion in ASTM oil No. 3 at 212 degrees F	ASTM D 471	Not more than plus 120 percent
Resistance to heat aging: change in original properties after 70 hours at 212 degrees F tensile strength ultimate elongation hardness	ASTM D 573	Plus 15 percent, minus 40 percent, 0 to plus 15 points
Resistance to permanent set: compression set after 22 hours at 212 degrees F	ASTM D 395 Method B	Not more than 35 percent
Resistance to ozone: condition after exposure of a sample kept under a surface tensile strain of 20 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F	ASTM D 1149	No cracks
Low-temperature stiffness: maximum Young's modulus at minus 20 degrees F	ASTM D 797	10,000 psi
		Not less than 200 pounds per linear inch

PROPERTY	TEST METHOD	PERFORMANCE
Hardness Shore A durometer	ASTM D 2240	70 plus or minus 5 points
Tensile strength	ASTM D 412, Die C	Not less than 17.2 Megapascal
Ultimate elongation	ASTM D 412, Die C	Not less than 300 percent
Resistance to oil aging: change in volume after 70-hour immersion in ASTM oil No. 3 at 100 degrees C	ASTM D 471	Not more than plus 120 percent
Resistance to heat aging: change in original properties after 70 hours at 100 degrees C tensile strength ultimate elongation hardness	ASTM D 573	Plus 15 percent, minus 40 percent, 0 to plus 15 points
Resistance to permanent set: compression set after 22 hours at 100 degrees C	ASTM D 395 Method B	Not more than 35 percent
Resistance to ozone: condition after exposure of a sample kept under a surface tensile strain of 20 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40 degrees C	ASTM D 1149	No cracks
Low-temperature stiffness: maximum Young's modulus at minus 7 degrees C	ASTM D 797	68.9 Megapascal
		Not less than 91 kilogram per 25 linear millimeter

2.6 GROUTING MATERIALS

****
NOTE: Delete the following paragraphs that are not applicable to the project. When fire-resistance rated precast structural-concrete sections are required, the applicable fire agency's requirements for grouting materials must be consulted.
****

****
NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive

Procurement Guidelines (CPG) (http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material. Written justification may be submitted on a Request for Waiver Form to the NASA Environmental Program Manager for approval. The Request for Waiver Form is located in the NASA Procedures and Guidelines (NPG 8830.1) (http://nodis3.gsfc.nasa.gov).

****

Portland cement shall conform to ASTM C 150, Type I.

Blended hydraulic cement shall conform to ASTM C 595, Type [_____].

Aggregate for cement grout shall conform to ASTM C 404, Size No. 2.

Shrinkage-resistant grouting compound shall be premixed and packaged ferrous aggregate conforming to ASTM C 1107, for expansive grouts.

Water shall be potable.

Epoxy-Resin Grout shall be two-component, mineral-filled, epoxy-polysulfide conforming to FS MMM-A-001993, Type I.

Epoxy-Resin Adhesive shall be two-component, epoxy-polyamide cured type conforming to AASHTO M 200.

2.7 BITUMINOUS JOINT SEALING MATERIALS

****

NOTE: Delete paragraph heading and the following paragraphs when single- or double-tee roof slab structural sections are not required.

****

Bituminous cement shall be asphalt conforming to ASTM D 312, Type IV.

Joint sealing tape shall be 6 inches 150 millimeter wide, multilayered, asphalt treated, glass-fiber reinforced, conforming to [ASTM D 2103] [ASTM D 4397] [FS UU-B-790, Type I, Grade C, Style 4,] with the following modification:

Dry tensile strength shall be not less than 35 pounds per inch 6130 newton per meter width, both directions.

2.8 FABRICATION

2.8.1 Fabrication Tolerances

****

NOTE: Delete the following fabrication tolerances

that are not required by the project.
****

Sections shall be fabricated within the following tolerances:

Overall dimensions	Plus or minus 1/8 inch per 10 feet but not greater than 3/4 inch overall
Cross-sectional dimensions of up to 6 inches	Plus or minus 1/8 inch
Over 6 to 18 inches	Plus or minus 3/16 inch
Over 18 to 36 inches	Plus or minus 1/4 inch
Over 36 inches	Plus or minus 3/8 inch
Deviation from straight line parallel to centerline of section up to 40 feet in length	Not over 3/8 inch
40 to 60 feet in length	Not over 1/2 inch
Over 60 feet in length	Not over 3/4 inch
Deviation from camber indicated on the drawings	Plus or minus 1/8 inch per 10 feet
Ends out of square, up to 12 inches in width or depth	1/32 inch per inch of width or depth
Over 12 inches in width or depth	1/32 inch plus 1/64 inch per inch of width or depth
Position of block-outs	Plus or minus 1/2 inch
Position of voids in hollow cored flat slabs, for both vertical and horizontal dimensions	Plus or minus 1/2 inch
Concrete cover over reinforcement	Plus 1/4, minus 0 inch
Position of tendons for pre-stressed concrete	Plus or minus 1/8 inch
Position of deflection points for deflected strand tendons for prestressed concrete	Plus or minus 6 inches
Position of weld plates	Plus or minus 1 inch
Position of lateral anchorage points	Plus or minus 1 inch
Position of pickup devices	Plus or minus 6 inches

Overall dimensions	Plus or minus 3 millimeter per 3048 millimeter but not greater than 19.1 millimeter overall
Cross-sectional dimensions of up to 150 millimeter	Plus or minus 3 millimeter
Over 150 to 460 millimeter	Plus or minus 4.8 millimeter
Over 460 to 915 millimeter	Plus or minus 6.4 millimeter
Over 915 millimeter	Plus or minus 9.5 millimeter
Deviation from straight line parallel to centerline of section up to 12.2 meter in length	Not over 9.5 millimeter
12.2 to 18.3 meter in length	Not over 12.7 millimeter
Over 18.3 meter in length	Not over 19.1 millimeter
Deviation from camber indicated on the drawings	Plus or minus 3 millimeter per 3 meter
Ends out of square, up to 305 millimeter in width or depth	0.80 millimeter per 25.4 millimeter of width or depth
Over 300 millimeter in width or depth	0.80 plus 0.40 millimeter per 25.4 millimeter of width or depth
Position of block-outs	Plus or minus 12.7 millimeter
Position of voids in hollow cored flat slabs, for both vertical and horizontal dimensions	Plus or minus 12.7 millimeter
Concrete cover over reinforcement	Plus 6.4, minus 0 millimeter
Position of tendons for pre-stressed concrete	Plus or minus 3.2 millimeter
Position of deflection points for deflected strand tendons for prestressed concrete	Plus or minus 152 millimeter
Position of weld plates	Plus or minus 25.4 millimeter
Position of lateral anchorage points	Plus or minus 25.4 millimeter
Position of pickup devices	Plus or minus 152 millimeter

2.8.2 Forms

****
NOTE: Structural-section dimensions, cross-sections, and other details as required by the project must be indicated.
****

Forms and form-facing materials shall be wood, metal, plastic, or other approved material that is nonreactive with concrete. Completed sections shall conform to the shapes, lines, and dimensions indicated and shall be within the limits of the specified fabrication tolerances.

2.8.3 Reinforcement

****
NOTE: Reinforcement types, sizes, and arrangement as required for structural strength after the structural sections have been installed must be indicated.
****

Reinforcing bars shall be of types, sizes, and arrangement as indicated on the approved drawings. Details of reinforcement shall be in accordance with ACI 318/318R, unless otherwise specified.

Steel bars, welded-wire fabric, and other reinforcement shall be placed and secured by means of metal bar supports and spacers.

****
NOTE: Delete the following paragraph when prestressed structural-concrete sections are not required by the project.
****

Tendons and anchorages shall be placed in accordance with ACI 318/318R. End anchorages that will be permanently protected with concrete shall be free of loose rust, grease, oil, paint, and other foreign matter. Bearing surface between anchorages and concrete shall be perpendicular to and concentric with the tendons and the line of action prestressing force.

****
NOTE: Revise the following paragraphs when not applicable to the project. Concrete cover for reinforcement must be indicated.
****

Concrete cover for reinforcement shall be in accordance with ACI 318/318R.

2.8.4 Built-In Anchorage Devices

****
NOTE: Anchorage devices that are to be embedded in the precast structural concrete sections must be indicated. Anchorage devices include weld plates, bearing plates and steel shapes.
****

Anchorage devices shall be positioned, anchored, and located where they do

not affect the position of the main reinforcement or placing concrete. Bearing plates shall be set level, aligned properly, and anchored in the exact location indicated.

2.8.5 Lifting Devices

Lifting devices shall be provided, shall be designed for 100-percent impact, and shall be of materials sufficiently ductile to ensure visible deformation before fracture.

2.8.6 Blockouts

****
NOTE: Blockouts or openings in slabs that would require the cutting of primary reinforcement if such openings were to be cut in the field must be cast in the unit during fabrication and must be indicated. The maximum size of field-cut openings may be from 6 to 12 inches 150 to 300 millimeter depending on the type of unit used such as the inside diameter of the voids in hollow cored flat slabs and the spacing of reinforcement.
****

Blockouts shall be provided as indicated.

2.8.7 Pretensioning

****
NOTE: Delete paragraph heading and the following paragraphs when prestressed structural-concrete sections are not required by the project.
****

Pretensioning of tendons may be accomplished either by the single-strand or multiple-strand tensioning method. Prestressing force shall be determined by measuring the tendon elongation, either by checking the jack pressure on a recently calibrated gage or by use of a recently calibrated dynamometer. Any discrepancy that exceeds 5 percent shall be corrected. Elongation requirements shall be based on the load-elongation curves for the type of tendon used. The total loss of prestress due to unreplaced broken tendons shall not exceed 2 percent of the total prestress.

2.8.8 Concrete Mixing and Conveying

Measuring concrete materials, concrete batching plant, concrete mixers, and concrete mixing shall be in accordance with ASTM C 94/C 94M.

Concrete shall be handled to prevent segregation and loss of concrete mix materials.

2.8.9 Preparations for Placing Concrete

Form interiors and reinforcement shall be free of accumulations of hardened concrete, form-parting compound, standing water, ice, snow, or other deleterious substances. Reinforcement and other embedded items shall be secured in position, inspected, and approved.

2.8.10 Weather Limitations

Concrete shall not be placed when temperature of the atmosphere is below 40 degrees F 5 degrees C nor during rain, sleet, and snow unless adequate protection is provided. Protection during inclement weather shall prevent the entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.8.11 Concrete Placing

Concrete shall be deposited so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. Concrete shall be consolidated in a manner that will prevent segregation and will produce concrete free of honeycomb or rock pockets and with the required surface finish.

2.8.12 Identification Markings

Each structural section shall be clearly marked in a permanent manner to indicate its location and orientation in the building and the pickup points.

Each structural section shall have the date of casting plainly indented in the unexposed face of the concrete.

2.8.13 Finishing Unformed Surfaces

Unformed surfaces shall have a trowel finish unless otherwise specified. Surface shall be smooth, free of trowel marks, uniform in texture and appearance, and shall be plane to a tolerance not exceeding 1/8 inch in 10 feet 3.2 millimeter in 3048 millimeter when tested with a 10-foot 3000 millimeter straightedge.

Top surfaces of sections that are to receive concrete topping after installation shall have a scratch finish. The surface shall be scarified transversely. Laitance shall be removed.

2.8.14 Curing

Concrete shall be cured by keeping the concrete damp for not less than 7 calendar ays if made of Type I portland cement and for not less than 3 calendar days if made of Type III portland cement. For each decrease of 5 degrees below 70 degrees F 3 degrees below 21 degrees C in the average curing temperature, the curing period shall be increased by 4 calendar days for concrete made of Type I portland cement and by 2 calendar days for concrete made of Type III portland cement.

Curing by low-pressure steam, steam vapor, radiant heat and moisture, or other acceptable process may be employed provided that the compressive strength of the concrete is equal to that obtained by moist curing and the 28-day compressive strength of the concrete meets the requirements specified, as determined by test cylinders of the same concrete cured by the same curing process.

Sections shall not be removed from their casting beds until the curing period is completed or concrete has attained at least 75 percent of its design compressive strength.

2.8.15 Protection of Concrete After Placing

Protection shall meet the requirements of ACI 305R or ACI 306R for hot or

cold weather, as applicable.

2.8.16 Detensioning

****
NOTE: Delete paragraph heading and the following paragraphs when prestressed structural-concrete sections are not required by the project.
****

Detensioning of tendons shall not be done until the concrete compressive strength, as indicated by test cylinders, is as follows:

TYPE OF REINFORCEMENT	TRANSFER STRENGTH OF CONCRETE
Concentrically stressed sections	Not less than 3,000 psi
Eccentrically stressed sections	Not less than 3,500 psi
Beams or other sections in which camber must be minimized	Not less than 4,000 psi

TYPE OF REINFORCEMENT	TRANSFER STRENGTH OF CONCRETE
Concentrically stressed sections	Not less than 20 Megapascal
Eccentrically stressed sections	Not less than 24.1 Megapascal
Beams or other sections in which camber must be minimized	Not less than 27.6 Megapascal

Test cylinders to be used to establish the compressive strength of the concrete shall be removed from the casting bed at least 1 hour prior to the start of the detensioning operation. Test cylinders from heat-cured casting beds shall be allowed to cool for approximately 1/2 hour prior to capping, and caps of sulfur compound shall be allowed to cure for 1/2 hour prior to the compressive-strength test.

If concrete has been heat cured, the detensioning operation shall be done following the curing period while the concrete is still warm and moist to avoid cracking or undesirable stresses in the concrete.

Prior to detensioning operations, forms, ties, inserts, holddowns, or other devices that would restrict the longitudinal movement of the sections along the casting bed shall be removed or loosened to provide free movement of the structural section. Alternately, detensioning shall be performed so that longitudinal movement is precluded.

In detensioning operations, prestressing forces shall be kept nearly symmetrical about the vertical axis of the section and shall be applied in a manner that will minimize sudden or shock loading. Maximum eccentricity about the vertical axis shall be limited to one strand. Detensioning of pretensioned tendons may be accomplished either by gradual release of the

tensioning jacks or by heat-cutting the tendons in accordance with an approved pattern and sequence to prevent severe unbalancing of the loading.

2.8.17 Finishing Formed Surfaces

Upon removal of forms, defective areas shall be repaired and patched. Defective areas shall be limited to holes left by tie rods and other temporary inserts and to honeycomb or rock pockets not deep enough to expose the reinforcement and not located in bearing areas. Defective areas shall be cut out to solid concrete and cleaned. Patches on lower side of sections, near the center or in areas of variable tensile strength, shall be bonded by a two-component epoxy-polysulfide or epoxy-polyamine bonding adhesive. Other areas shall be dampened with water and patched with portland cement grout. Where the concrete surface will be exposed to view, the patches, when dry, shall match the surrounding concrete.

Formed surfaces of sections that will be concealed by other construction shall have the standard smooth finish. The standard smooth finish shall be the concrete surface having the texture imparted by the forms. Defective areas shall be repaired and patched as specified and all fins and other projections removed.

****

NOTE: Delete the following paragraph and specify the required finish when an architectural finish is required. For an exposed-aggregate finish refer to Section 03475 PRECAST CONCRETE WALL PANELS. The location of precast structural concrete sections having an architectural finish must be indicated.

****

Formed surfaces of sections that are to be exposed-to-view after installation shall have grout finish. Final color of the grout, when dry, shall be the same for all concrete surfaces. Grout shall be spread over dampened concrete surface with clean burlap pads, carpet, or sponge rubber floats to fill pits, air bubbles, and surface holes. Excess grout shall be removed by scraping and then rubbing the surface with clean burlap or carpet to remove visible grout film. In hot dry weather, grout shall be kept damp by means of fog-spraying during the setting period.

PART 3 EXECUTION

3.1 GENERAL

Sections shall be installed in accordance with the approved drawings and as specified.

3.2 ANCHORAGE ITEMS EMBEDDED IN OTHER CONSTRUCTION

****

NOTE: Delete the paragraph heading and the following paragraph when precast structural-concrete sections will not be connected to cast-in-place concrete construction or masonry construction. Such anchorage items include anchor bolts, steel dowels, and steel bearing plates.

****

Items shall be delivered to the site before the start of other

construction. Setting drawings, templates, instructions, and directions shall be provided for the installation of anchorage items.

3.3 INSTALLATION OF FLEXIBLE BEARING PADS

****
NOTE: Delete paragraph heading and the following paragraphs when flexible bearing pads are not required. Bearing pads must be indicated.
****

Pads shall be installed where indicated, set in correct position, and have a uniform bearing. Pads shall be kept in the correct position while placing sections.

3.4 STRENGTH OF STRUCTURAL SECTIONS AT INSTALLATION

****
NOTE: Delete one of the following paragraphs as applicable to the project. The first paragraph shall be selected except when the project schedule indicates installation of 28-day structural sections.
****

Sections shall not be installed until concrete has attained the specified minimum laboratory strength at 28 calendar days.

Sections shall not be installed before 28 calendar days from the date of casting has elapsed unless approval has been obtained to make one compressive-strength test, ASTM C 39/C 39M, and one flexural strength test using simple beam with third point loading, ASTM C 78, on field cured concrete test specimens, ASTM C 31, for each individual structural section to determine the strength of the concrete.

3.5 INSTALLATION TOLERANCES

Sections shall be installed within the following tolerances:

Deviation in location from indicated	Plus or minus 1/4 inch
Deviation from plumb for columns in any story or 20 feet maximum	Not over 1/4 inch
In 40 feet or more	Not over 1/2 inch
Deviation from elevations indicated for girders, beams, joists, and slabs in any bay or 20 feet maximum	Not over 1/4 inch
In 40 feet or more	Not over 1/2 inch
Difference between adjacent structural sections in erected position	Plus or minus 1/16 inch per 10 feet but not greater than 1/4 inch overall

Deviation in location from indicated	Plus or minus 6.4 millimeter
Deviation from plumb for columns in any story or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Deviation from elevations indicated for girders, beams, joists, and slabs in any bay or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Difference between adjacent structural sections in erected position	Plus or minus 1.6 millimeter per 3000 millimeter but not greater than 6.4 millimeter overall

3.6 PLACING FRAMING STRUCTURAL SECTIONS

****

NOTE: Delete paragraph heading and the following paragraphs when framing structural sections such as columns, beams, girders, and joists will not be required.

****

Supporting sections, including anchorage items attached to or embedded in other construction, shall be in place before placing sections is started.

****

NOTE: Delete the following paragraphs when precast concrete columns with attached steel bearing plates will not be required.

****

Installation of precast concrete columns with attached steel bearing plates shall be as follows:

Concrete and steel plate bearing surfaces shall be cleaned of laitance, dirt, oil, grease, and other foreign materials. Concrete surface shall be roughened.

Space between the top of the concrete bearing surface and the bottom of the steel plate shall be approximately 1/24 of the width of the bearing plate, but not less than 1/2 inch 12.7 millimeter for bearing plate that is less than 12 inches 300 millimeter wide. Bearing plate shall be supported and aligned on steel wedges or shims.

After precast concrete columns have been positioned and braced and anchor bolts tightened, the space between the top of the bearing surface and the bottom of the steel bearing plate shall be grouted.

Wedges or shims shall not be removed but, when protruding, shall be cut off flush with the edge of the steel bearing plate prior to grouting.

Sections shall be installed plumb, level, and in alignment within the limits of the installation tolerances specified.

3.7 PLACING SLAB STRUCTURAL SECTIONS

****
NOTE: Delete the paragraph heading and the following paragraphs when slab structural sections, such as single- and double-tee slabs and hollow-cored flat slabs will not be required. Slab structural-sections may be placed over structural-steel framing members, precast structural-concrete framing sections, cast-in-place structural-concrete framing sections, or bearing walls, or a combination thereof.
****

Supporting sections, including bearing pads or plates, shall be in place before placing sections is started. Slab structural sections shall be placed on supporting construction with ends bearing on the structural framing sections or bearing walls as indicated. End bearings shall be not less than 3 inches 75 millimeter. Slabs shall be accurately aligned end to end with sides and ends butted together. Grouting void shall be provided at sides and ends of the slabs as indicated.

****
NOTE: Delete the following paragraph when electrical-raceway hollow-cored flat-slab structural sections will not be required.
****

Electrical raceway hollow-cored flat-slab structural sections shall be placed in straight alignment for the entire length of run of the hollow cores and with close alignment between hollow cores at the ends of abutting slab structural sections.

3.8 WELDED CONNECTIONS

****
NOTE: Welded connections are the most commonly used type of connection. Other types of connections that may be employed are gravity, structural-steel bolted, post-tensioned, cast-in-place reinforced-concrete, and doweled connections. Connection details must be indicated.
****

Welding reinforcing steel, metal inserts, and connections in precast-concrete structural-member construction shall be in accordance with AWS D1.4.

Welding structural steel connections shall be in accordance with AWS D1.1/D1.1M Code.

3.9 GROUTING CONNECTIONS AND JOINTS

****
NOTE: Delete paragraph heading and the following paragraphs when precast structural-concrete framing

sections or floor-slab structural sections or both will not be required. When fire-resistance-rated precast structural-concrete sections are required, the applicable fire agency's requirements for grouting joints shall be consulted.

****

After sections have been placed and connected, open spaces at connections and joints shall be grouted.

****

NOTE: Delete the following paragraph when shrink-resistant grout only is required.

****

Cement grout shall be of 1 part cement, 2-1/2 parts of specified aggregate for cement grout, and not more than 4-1/2 gallons 17 liter of water per 94-pound 42.6 kilogram sack of cement.

****

NOTE: Delete the following paragraph when cement grout only is required.

****

Shrink-resistant grout compound shall be mixed with water to provide a flowable mixture without segregation or bleeding.

Forms or other approved methods shall be provided to retain the grout in place. Spaces to be grouted shall be packed with grout until the voids are completely filled. At slab structural sections, grout shall finish level with top surface of the slab. Excess grout shall be removed. Grout shall be kept damp for not less than 24 hours.

****

NOTE: Delete the following paragraphs when cement grout only is required or when epoxy-resin grout or adhesive instead of shrink-resistant grout is not required.

****

Epoxy-resin grout or adhesive may be used in lieu of shrink-resistant grout. Installation of epoxy-resin grout or adhesive shall be in accordance with the manufacturer's printed instructions.

****

NOTE: Delete the following paragraph when electrical raceway hollow-cored flat-slab structural sections are not required.

****

Open spaces at abutting ends of electrical raceway hollow-cored flat-slab structural sections shall be sealed with pressure-sensitive tape. Hollow cores used for electrical raceways shall be kept free from grout and other foreign materials.

3.10 SEALING JOINTS IN ROOF SLABS

****

NOTE: Delete paragraph heading and the following

paragraphs when roof slab structural sections will not be required. Where fire-resistance-rated roof slab structural sections are required, the applicable fire agency's requirements for sealing joints must be consulted.

****

After precast-concrete roof slab sections have been placed and connected, open spaces at connections and the top portion of joints shall be sealed.

Keyways and joints at ridges, hips, and connections shall be filled with cement grout. Grout shall be level with the top surfaces of slabs. Excess grout shall be removed, and the grout surface shall be given a smooth finish.

Other joints shall be sealed with bituminous joint-sealing material. Joint-sealing tape shall be centered over the joint and embedded in hot bituminous cement. End laps shall be not less than 4 inches 100 millimeter. Excess bitumen shall be removed; the tape surface shall be smooth.

3.11 OPENINGS IN SLAB STRUCTURAL SECTIONS

****

NOTE: The maximum size of field-cut openings is governed by the spacing of reinforcement and the inside diameter of the voids in hollow-cored flat slabs.

****

Cutting and fitting sections shall be performed as required for other work projecting through, or adjacent to, the members. Cuts shall be straight and at 90 degrees to the surfaces without breaking or spalling the edges.

****

NOTE: Delete the following paragraph when hollow-cored flat-slab structural sections will not be required. Openings larger than the width of a slab structural section must be framed with supporting members.

****

Openings in hollow-core flat-slab sections having any dimension more than the inside diameter of the hollow cores and not exceeding the width of the slab structural section shall be reinforced by means of hung steel angle saddle headers. Headers shall be shop prime-coat painted and shall be as indicated on the approved drawings.

3.12 TOUCHUP PAINTING

****

NOTE: Delete paragraph heading and the following paragraph when precast structural-concrete sections will not be supported by steel structural members.

****

After sections have been installed, scarred surfaces on steel supporting members and weld plates shall be wire brushed, cleaned, and touchup painted.

3.13 PROTECTION AND CLEANING

****
NOTE: Where architectural finishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces must be cleaned as specified in Section 03475 PRECAST CONCRETE WALL PANELS.
****

Exposed-to-view surfaces shall be protected against staining and other damage until completion of the work.

Upon completion of installation, slab surfaces shall be swept clean and left ready to receive concrete floor topping, roofing, or other covering.

3.14 INSPECTION AND ACCEPTANCE PROVISIONS

3.14.1 Evaluation of Compressive Strength Tests

Concrete quality control tests will be evaluated as specified.

****
NOTE: Delete the following paragraph when normal-weight concrete will not be required.
****

Normal-weight concrete delivered to the point of placement having a slump or total air content outside the values specified shall not be used in the work.

****
NOTE: Delete the following paragraph when lightweight structural concrete will not be required.
****

Lightweight structural concrete delivered to the point of placement having a unit weight of fresh concrete that varies more than 2 percent from the design mix wet unit weight or having a slump or total air content outside the values specified shall not be used in the work.

Compressive-strength tests will be considered satisfactory if the average of any group of 5 consecutive compressive-strength tests that may be selected is in each instance equal to or greater than the 28-day design compressive strength or if not more than one compressive-strength test in 10 has a value less than 90 percent of the 28-day design compressive-strength.

If the compressive-strength tests fail to meet the minimum requirements specified, the sections fabricated of concrete represented by such tests will be considered deficient in strength and subject to the provisions specified.

3.14.2 Dimensional Tolerances

Members having any dimension outside the limits for fabrication tolerances specified will be rejected.

3.14.3 Surface-Finish Requirements

Sections will be rejected for any of the following surface-finish deficiencies:

****
NOTE: Delete the first of the following paragraphs when architectural finishes such as exposed-aggregate finish, are not required for exposed-to-view surfaces.
****

Exposed-to-view surfaces having architectural finishes that do not match the color, aggregate size and distribution, and texture of the approved sample for the exposed-to-view finish

Exposed-to-view formed surfaces that contain cracks, spalls, air bubbles, honeycomb, rock pockets, or stains or other discoloration that cannot be removed by cleaning

Concealed formed surfaces that contain cracks in excess of 0.01 inch 0.25 millimeter wide; cracks or any other surface deficiency that penetrates to the reinforcement regardless of the width of crack or size of other deficiency; honeycomb and rock pockets located in bearing surfaces; and spalls except minor breakage at corners

Unformed surfaces that contain cracks and other surface deficiencies as specified for concealed formed surfaces

3.14.4 Strength of Structural Members

Strength of precast structural-concrete sections will be considered potentially deficient if they fail to comply with the requirements that control the strength of the structural members, including the following conditions:

Failure to meet compressive strength tests

Reinforcement and pretensioning and detensioning of tendons of prestressed concrete not conforming to the requirements specified

Concrete curing and protection of structural sections against extremes in temperature during curing not conforming to the requirements specified

Structural sections damaged during handling and erection

3.14.5 Testing Structural Sections for Strength

When there is evidence that the strength of precast structural-concrete sections does not meet specification requirements, cores drilled in hardened concrete for compressive strength determination shall be made in accordance with ASTM C 42/C 42M and as follows:

At least three representative cores shall be taken from the precast structural concrete sections that are considered potentially deficient.

Cores shall be tested saturated-surface-dry if the concrete they represent will be wet at all times during the use of the completed

structure.

Cores shall be tested air-dry if the concrete they represent will be dry at all times during the use of the completed structure.

Strength of cores will be considered satisfactory if their average is equal to or greater than the 28-day design compressive strength of 6-by 12-inch 150 by 300 millimeter cylinders.

Core holes shall be solidly filled with patching mortar and finished to match the adjacent concrete surfaces.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, static load tests shall be made of a structural section and will be evaluated in accordance with ACI 318/318R, except that the superimposed test load shall be as specified for the proof-test method of strength design.

Sections that are found inadequate by the core tests or by the results of static load tests shall be replaced with sections that meet the specified requirements.

3.14.6 Inspection of Welding

****

NOTE: Delete paragraph heading and the following paragraphs when inspection of welding will not be required.

****

Inspection of welding shall be performed in accordance with AWS D1.1/D1.1M, Section entitled, "Inspection," and as follows:

****

NOTE: Delete the following paragraphs that are not applicable to the project. The location of welds requiring inspection and the type of inspection must be indicated. The liquid-penetration inspection of welds is the most economical and commonly used method.

****

Liquid-penetration inspection of welds shall conform to ASTM E 165.

Magnetic-particle inspection of welds shall conform to ASTM E 709.

3.14.7 Structural Sections-in-Place

Sections-in-place will be rejected for any one of the following deficiencies:

Sections not conforming to the requirements for installation tolerances specified

Sections that are damaged during construction operations

Sections having exposed-to-view surface finishes that develop surface finish deficiencies specified

-- End of Section --